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Chapter 19. Urban Runoff Management

Urban runoff management is a broad series of activities to manage both storm water and dry weather runoff. Dry weather runoff occurs when, for example, excess landscape irrigation water flows to the storm drain. Traditionally, urban runoff management was viewed as a response to flood control concerns resulting from the effects of urbanization. Concerns about the water quality impacts of urban runoff have led water agencies to look at watershed approaches to control runoff and provide other benefits (see Box 19-1, Objectives of Urban Runoff Management), resulting in urban runoff management now being linked to other resource management strategies including Pollution Prevention, Land Use Planning and Management, Watershed Management, Urban Water Use Efficiency, Recycled Municipal Water, Recharge Area Protection, and Conjunctive Management.

PLACEHOLDER Box 19-1 Objectives of Urban Runoff Management

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of this chapter.]

Urban Runoff Management in California

The traditional approach to runoff management views urban runoff as a flood management problem where water needs to be conveyed as quickly as possible from urban areas to waterways in order to protect public safety and property. Consequently, precipitation-induced runoff in the urban area has been viewed as a waste, and not a resource.

Urbanization alters flow pathways, water storage, pollutant levels, rates of evaporation, groundwater recharge, surface runoff, the timing and extent of flooding, the sediment yield of rivers, and the suitability and viability of aquatic habitats. The traditional approach to managing urban and storm water runoff has generally been successful at preventing flood damage, but has several disadvantages. In order to convey water quickly, natural waterways are often straightened and lined with concrete, resulting in a loss of habitat and impacts to natural stream physical and biological processes. Urbanization creates impervious surfaces resulting in the loss of infiltration of storm water into subsurface aquifers. These impervious surfaces collect pollutants that are washed off to surface waters during rain events. The impervious surfaces also increase runoff volumes and velocities, resulting in streambank erosion, and potential flooding problems downstream. Because of the emphasis on removing the water quickly, the opportunity to use storm-generated runoff for multiple benefits is reduced.

A watershed approach for urban runoff management tries to emulate and preserve the natural hydrologic cycle that is altered by urbanization. The watershed approach consists of a series of best management practices (BMPs) designed to reduce the pollutant loading and reduce the volumes and velocities of urban runoff discharged to surface waters. These BMPs may include facilities to capture, treat, and recharge groundwater with urban runoff; public education campaigns to inform the public about storm water pollution including the proper use and disposal of household chemicals; and technical assistance and storm water pollution prevention training.

Methods for recharging groundwater with urban runoff include having roof runoff drain to vegetated areas, draining runoff from parking lots, driveways, and walkways into landscaped areas with permeable soils, using dry wells and permeable surfaces, and collecting and routing storm water runoff to basins. Infiltration may require the use of source control and pretreatment before infiltration. Infiltration enables the soil to naturally filter many of the pollutants found in runoff and reduces the volume and pollutant load of the runoff that is discharged to surface waters. The watershed approach will not prevent, nor should it prevent, all urban runoff from entering waterways. Elements of the traditional conveyance and storage strategy are still needed in order to protect downstream beneficial uses, water right holders, and the public from floods. In addition to infiltration of storm water, other BMPs include the use of rain barrels and cisterns to "harvest" storm water for later use (e.g., irrigation), and the use of structural controls which are designed to capture storm water runoff and slowly release it into streams in order to mimic the natural hydrograph that existed before development occurred.

Urban runoff management has become more important and more controversial over the last two decades as municipal governments have been held increasingly responsible for pollutants washed from developed and developing areas within their jurisdictions into the storm sewer system and discharged into waterways. Unlike pollution from industrial and sewage treatment plants, pollutants in urban runoff and storm water runoff come from many diffuse sources (see Box 19-2) and typically are not treated prior to discharge to surface waters. As rainfall or snowmelt moves over the urban landscape, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and, potentially, into groundwater. Pollution associated with discharges from a storm sewer system can also occur from non-storm event activities, such as flows from landscape irrigation, improper disposal of trash or yard waste, illegal dumping, and leaky septic systems.

PLACEHOLDER Box 19-2 Examples of Pollution in the Urban Environment

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of this chapter.]

Runoff in the urban environment, both storm-generated and dry weather flows, has been shown to be a significant source of pollutants to the surface waters of the nation. As a result, the 1987 amendments to the federal Clean Water Act (CWA) required that discharges from municipal separate storm sewer systems serving a population of 100,000 or more must be in compliance with requirements contained in National Pollutant Discharge Elimination System (NPDES) permits. The US Environmental Protection Agency (USEPA) promulgated regulations for these discharges in 1990. These regulations were subsequently amended in 1999 to require that municipal separate storm sewer systems that served populations fewer than 100,000 and located in an urbanized area were subject to requirements contained in an NPDES permit. In California, the authority to regulate urban and storm water runoff under the NPDES system has been delegated by USEPA to the State Water Resources Control Board (State Water Board) and the nine Regional Water Quality Control Boards (Regional Water Boards).

Under the initial NPDES permits issued in the 1990s, municipalities were required to develop and implement a plan to reduce the discharge of pollutants into waterways, including the discharges from areas of new development and significant redevelopment. For the new and redevelopment projects, the permit requirements were generally met through the implementation of BMPs that addressed discharges taking place during the construction activity, but did not address discharges occurring after construction was completed (post-construction controls). Since the first municipal storm water permits were adopted, it has become clear, with continued beach closures and other pollution problems associated with urban runoff, that post-construction controls, retrofit and more advanced measures will be required in some areas to comply with water quality regulations (see Box 19-3).

PLACEHOLDER Box 19-3 Implementation Plan for Urban Runoff Management Programs

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of this chapter.]

The State and Regional Water Boards seek opportunities for managing urban runoff that will result in multiple benefits. Low Impact Development (LID) is one such collection of management techniques that has multiple benefits. LID is a sustainable practice that benefits water supply and contributes to water quality protection. Unlike traditional storm water management, which collects and conveys storm water runoff through storm drains, pipes, or other conveyances to a centralized storm water facility, LID takes a different approach by using site design and storm water management to maintain the site's pre-development runoff rates and volumes. The goal of LID is to mimic a site's predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source of rainfall. LID has been a proven approach in other parts of the country and is seen in California as an alternative to conventional storm water management. The Water Boards are advancing LID in California in various ways.

LID can be used to benefit water quality, address the modifications to the hydrologic cycle and be a means to augment local water supply through either infiltration or water harvesting. In light of this, the Water Boards are incorporating the principals of LID into the permits now being issued, and are funding projects that highlight LID using the various voter-approved bond funds.

The State and Regional Water Boards are also required under the federal CWA section 303(d) and federal regulations (40 C.F.R. § 130) to prepare a list of and set priorities for water bodies requiring total maximum daily loads (TMDLs) because they do not meet water quality standards. The section 303(d) list was last revised in 2010. Federal regulations require the section 303(d) list to be updated every two years. TMDLs represent the total pollutant load a water body can assimilate before the water body's beneficial uses are considered to be impaired and water quality standards are no longer met. Through the process to establish the 303(d) list of impaired water bodies, urban runoff has often been found to be a source of pollutants contributing to the impairment.

NPDES permits now issued to local agencies for discharges of storm water require the implementation of specific measures to reduce the amount of pollutants in urban runoff. Permits for discharge to listed water bodies having a TMDL must be consistent with the waste load allocations in a TMDL. Under California law, TMDLs include implementation plans for meeting water quality standards. The implementation plans allow for time to implement control strategies to meet water quality standards.

Potential Benefits of Urban Runoff Management

The primary benefits of urban runoff management are to reduce surface water pollution and improve flood protection. Additional benefits may be to increase water supply through groundwater recharge in areas with suitable soil and geological conditions, and where pollution prevention programs are in place to minimize the impact on groundwater. Groundwater recharge and storm water retention sites can also be designed to provide additional benefits to wildlife habitat, parks, and open space.

Underground facilities can store runoff and release it gradually to recharge a groundwater aquifer or release it to surface waters in a manner that mimics the natural hydrologic cycle. Captured storm water can also be used as a source of irrigation water rather than using potable water. For instance, a school campus can solve its flooding problem and develop a new sports field at the same time. These may provide secondary benefits to the local economy by creating more desirable communities. By keeping runoff onsite, storm drain systems can be downsized, reducing installation and maintenance costs of such systems. A watershed planning approach to manage urban runoff allows communities to pool economic resources and obtain broader benefits to water supply, flood control, water quality, open space, and the environment. Statewide information on the benefits of increased management of urban runoff is not available, although examples from local efforts exist.

The Fresno-Clovis metropolitan area has built an extensive network of storm water retention basins that not only recharges more than 70 percent of the annual storm water runoff (17,000 acre feet) and removes most conventional storm water pollutants, but also recharges excess Sierra snowmelt during the late spring and summer (27,000 acre-feet). Los Angeles County recharges an average 210,000 acre-feet (AF) storm runoff a year, which reduces the need for expensive imported water. Agencies in the Santa Ana watershed recharge about 78,000 AF of local storm runoff a year. The Los Angeles and San Gabriel Watershed Council has estimated that if 80 percent of the rainfall that falls on just a quarter of the urban area within the watershed (15 percent of the total watershed) was captured and reused, total runoff would be reduced by about 30 percent. That translates into a new supply of 132,000 AF of water per year or enough to supply 800,000 people for a year.

The City of Santa Monica is an example of a municipality that is taking a watershed approach to managing urban runoff. Santa Monica’s primary goal is to treat and reuse all dry weather flows. This turns a perceived waste product into a local water resource so that beach water quality is protected and the local nonpotable water supply is augmented. However, if dry weather discharges are necessary, the city’s secondary goal is to release only treated runoff into waterways. Both goals improve water quality of the Santa Monica Bay. The city’s goals promote development such that urbanization works with nature and the hydrologic cycle.

At the “lot” or home-owner level, LID techniques and practices can be used to reduce the amount of runoff being generated and slow its release to the storm sewer system or surface waters. Captured runoff can be harvested and stored for later use on-site. LID techniques and practices include but are not limited to rain barrels (cisterns), rain gardens, swales, trench drains, land grading, permeable pavers, tree-box filters, and green roofs. For further discussion, see the Land Use Planning and Management resource management strategy, Chapter 24 in this volume. A recent analysis aimed at quantifying the benefits of LID techniques was conducted by the Natural Resources Defense Council and University of California at Santa Barbara and is summarized in Box 19-4; the full report is included in Volume 4 (NRDC et al., 2009).

PLACEHOLDER Box 19-4 Recent Efforts to Quantify Benefits of Low Impact Development

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of this chapter.]

Potential Costs of Urban Runoff Management

Information is not available on statewide costs to implement urban runoff management activities. The State Water Board contracted with the Office of Water Programs, California State University, Sacramento, to survey six communities to estimate the costs of complying with their NPDES storm water permits (CSUS, 2005). While this may address the cost for a municipality to comply with specific programmatic elements of an NPDES permit, it may not be the most applicable for looking at watershed programs seeking multiple benefits.

The City of Santa Monica illustrates the costs of managing urban runoff from the perspective of treating dry weather flows. The city has a storm water utility fee that generates about $1.2 million annually, and has been in place since 1995. These funds are used for various programs to reduce or treat runoff. These funds go to the Urban Runoff Management Coordinator for the maintenance of the storm drain system and to help support other city staff that conduct runoff work. Additional funds are spent by other divisions to perform runoff management such as street sweeping, some trash collection, sidewalk cleaning, and purchase and maintenance of equipment. The city has also received five grants totaling more than $3.5 million for the installation of structural BMP systems, all of which will require long-term maintenance and monitoring by the city. The culmination of the city's program is the $12 million Santa Monica Urban Runoff Recycling Facility (SMURRF), a joint project of the cities of Santa Monica and Los Angeles. The SMURRF project is a state-of-the-art facility that treats dry weather runoff water before it reaches Santa Monica Bay. Up to 500,000 gallons per day of urban runoff generated in parts of the cities of Santa Monica and Los Angeles can be treated by conventional and advanced treatment systems at the SMURRF.

Major Issues Facing Urban Runoff Management

Lack of Integration with Other Resource Management Strategies

Land use planning is not conducted on a watershed basis. Many agencies spend millions of dollars annually addressing urban runoff problems with very little interagency coordination (both within the municipality and with other neighboring municipalities) even though downstream communities can be impacted by activities upstream. In other words, internal communications within local government can be improved to ensure that program goals and direction of one branch do not conflict with those of another; and local governments need to communicate with one another to ensure that land use planning on a regional level is complementary across jurisdictional boundaries.

Solutions to managing urban runoff are closely tied to many interrelated resource management strategies including land use planning, watershed planning, water use efficiency, recycled water, protecting recharge areas, and conjunctive management. How and why water is used in the urban environment needs to be considered comprehensively within a watershed.

Climate Change

With climate change comes the potential for storm events to become more episodic. Rainfall patterns, the time and intensity of storms, frequency of storms, and the amount of precipitation an area receives may change. All of this will result in changes in what we consider to be the averages used to design the storm sewer system. What is now an adequately sized system may become undersized in the future, leading to localized flooding.

Adaptation

How future urban areas are built and how current urbanized areas change over time will determine how well urbanized areas adapt and respond to climate change. Newly developing areas can minimize impervious areas, use regionally appropriate landscaping features, and seek opportunities for harvesting rain water for onsite use and/or infiltrating rain fall into ground water aquifers. Existing development can seek opportunities for harvesting, reducing impervious areas and infiltration.

Mitigation

Harvesting rain water at the site level and infiltrating it on a regional scale can result in reducing localized flooding, as well as increasing local water supply through groundwater recharge. Harvesting when combined with the use of regionally appropriate landscaping can also reduce the amount of water needed to be delivered to the home for landscape irrigation.

Lack of Funding

The two main aspects of implementing urban runoff management measures are source control, including education, and structural controls. In highly urbanized areas, major costs for structural control include purchasing land for facilities and constructing, operating and maintaining treatment facilities. Local municipalities have limited ability to pay for retrofitting existing developed areas within existing budgets. Some are concerned about the economic impacts of raising taxes and requiring residents and businesses to pay for retrofitting existing development. The provisions of Proposition 218 have limited local municipalities' ability to increase fees to pay for services required to implement robust urban runoff management programs.

Effects of Urban Runoff on Groundwater Quality

The movement of pollutants in urban runoff is a concern. Urban runoff contains chemical constituents and pathogenic indicator organisms that could impair water quality. Studies by EPA (USEPA, 1983) and the US Geological Survey (Schroeder, 1993) indicate that all monitored pollutants stayed within the top 16 centimeters of the soil in the recharge basins. The actual threat to groundwater quality from recharging urban runoff is dependent on several factors, including soil type, source control, pre-treatment, solubility of pollutants, maintenance of recharge basins, current and past land use, depth to groundwater, and the method of infiltration used.

Nuisance Problems/Other Concerns

The presence of standing water in recharge basins and other drainage and storage structures can lead to vector problems, such as mosquitoes and the transmission of West Nile Virus. The California Department of Public Health has developed guidelines that address the issue of vector control in basins. These same concerns also apply to the onsite capture of runoff for later use.

Infiltration is being encouraged by a number of state agencies and has been found to be an effective means of dealing with surface water pollution and the excess volumes and velocities of runoff created in the urban environment. However, it is also acknowledged that infiltration is not appropriate in all circumstances. Examples of this would be the widespread use of infiltration in a brownfield development or infiltrating large amounts of water in hillside developments where slope stability may be an issue.

Protecting Recharge Areas

Local land use plans often do not recognize and protect groundwater recharge and discharge areas. Areas with soil and geologic conditions that allow groundwater recharge should be protected where appropriate. If development does occur in these areas, the amount of impervious cover should be minimized and infiltration of storm water should be encouraged on both a regional scale as well as at the "lot" level. The Los Angeles and San Gabriel Rivers Watershed Council prepared a Water Augmentation Study which looked at the results of storm water infiltration and the impact on groundwater (LASGRWC, 2008). Refer to the Recharge Areas Protection, Chapter 25 in Volume 2, for additional information.

Misperceptions

The general public may not always understand that urbanization and life in an urbanized environment is a source of pollution. The public may not realize that they are both the source/cause of pollution in the urban environment and the solution. Elected officials do not always understand the links between land use management and other resource management strategies and how these affect water quality. There is a lack of understanding that decisions made, short-term and long-term, can either enhance or exacerbate the problems associated with pollutants in the urban environment.

Existing Codes

There are current codes and ordinances within State and local government that could conflict with some of the goals of managing urban runoff. Dry weather flows have been shown to be significant sources of pollution, with one of the primary dry weather flows being runoff associated with landscape irrigation and lawn watering. Reduction/elimination of these flows not only provides a water quality benefit, but also reduces the amount of potable water that is being used in a community. However, some municipalities have "green lawn" ordinances and compliance oftentimes leads to runoff. Other codes require minimum street widths that can inhibit the minimization of impervious surfaces.

Recommendations to Promote Urban Runoff Management

State

State agencies should:

1. Coordinate their efforts to decide how urban runoff management should be integrated into their work plans.
2. Coordinate their efforts to develop a single message to the public and local government regarding managing urban runoff through the use of low impact development techniques.
3. Coordinate their efforts to develop appropriate site design requirements that can be incorporated into either local building codes or statewide building standards.
4. Lead by example by incorporating low impact development into projects to showcase the use, utility and cost of the features. Site design should be given the same attention that indoor environmental quality, energy usage, etc., are given in the design, funding and construction of public projects.
5. Encourage public outreach and education about the benefits and concerns related to funding and implementation of urban runoff measures.
6. Provide leadership in the integration of water management activities by assisting, guiding, and modeling watershed and urban runoff projects.
7. Work with local government agencies to evaluate and develop ways to improve existing codes and ordinances that currently stand as barriers to implementing and funding urban runoff management.
8. Provide funding and develop legislation to support development of urban runoff and watershed management plans, enable local agencies and organizations to pursue joint venture, multipurpose projects, and collect information on regional urban runoff management efforts.
9. Assist agencies with developing recharge programs with appropriate measures to protect human health, the environment, and groundwater quality.
10. Work with federal policy makers and industry to create research and development incentives and to develop standards to reduce urban runoff from transportation-related sources including lubricant systems, cooling systems, brake systems, tires, and coatings.
11. Maintain a publicly accessible clearinghouse of information regarding practices that can be used to address water quality issues associated with urban runoff management.
12. Work with local government to seek legislative solutions to the limitations imposed by Proposition 218.

Local Agencies and Governments

Local agencies and governments should:

13. Design recharge basins to minimize physical, chemical, or biological clogging, periodically excavate recharge basins when needed to maintain infiltration capacity, develop a groundwater management plan with objectives for protecting both the available quantity and quality of groundwater, and cooperate with vector control agencies to ensure the proper mosquito control mechanisms and maintenance practices are being followed.
14. Seek opportunities to include low impact development techniques in public works projects.
15. Work with the development community to identify opportunities to address urban runoff management, including low impact development, in development and redevelopment projects.
16. When developing Urban Runoff Management Plans:

A. Understand how land use affects urban runoff.
B. Communicate with other municipalities regarding how land use will change the hydrologic regime on a regional basis and how this change is being addressed.
C. Look for opportunities to require features that conserve, clean up, and reduce urban runoff in new development, and in more established areas when redevelopment is proposed.
D. Be aware of technological advances in products and programs through communications with other municipalities, branches of local government and with professional organizations.
E. Learn about urban runoff and watershed ordinances already in place. For example, the City of Santa Monica and the Fresno Metropolitan Flood Control District already have extensive urban runoff management programs in place.
F. Integrate urban runoff management with other resource management strategies including Pollution Prevention, Land Use Planning and Management, Watershed Management, Urban Water Use Efficiency, Recycled Municipal Water, Recharge Areas Protection, and Conjunctive Management and coordinate both within and across municipal boundaries.
G. Be sensitive to the fact there are going to be sites where it is not appropriate to infiltrate urban runoff and storm water flows.
H. Integrate urban runoff management with development goals and strategies in the community

17. Communicate with citizens about pollution of urban runoff and what can be done about it.
18. Create lists of locally accepted practices that could be used at the homeowner level to address urban runoff.
19. Review codes and ordinances to determine if there are impediments to managing urban runoff and amend these as needed or appropriate.
20. Coordinate urban runoff management with local water purveyors to ensure the goals and activities of each complement rather than conflict.
21. Seek opportunities to provide incentives for the installation of low impact development features at the lot level for new and existing developments.

Urban Runoff Management in the Water Plan

[This is a new heading for Update 2013. If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions aren't consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy isn't discussed in the rest of Update 2013), there is no need for this section to appear.]

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